Feb. 28, 1956 V. G. MATHISON 2,736,313

ELECTROPSYCHOMETER OR BIOELECTRONIC INSTRUMENT

Filed Oct. 5, 1954 3 Sheets-Sheet 1

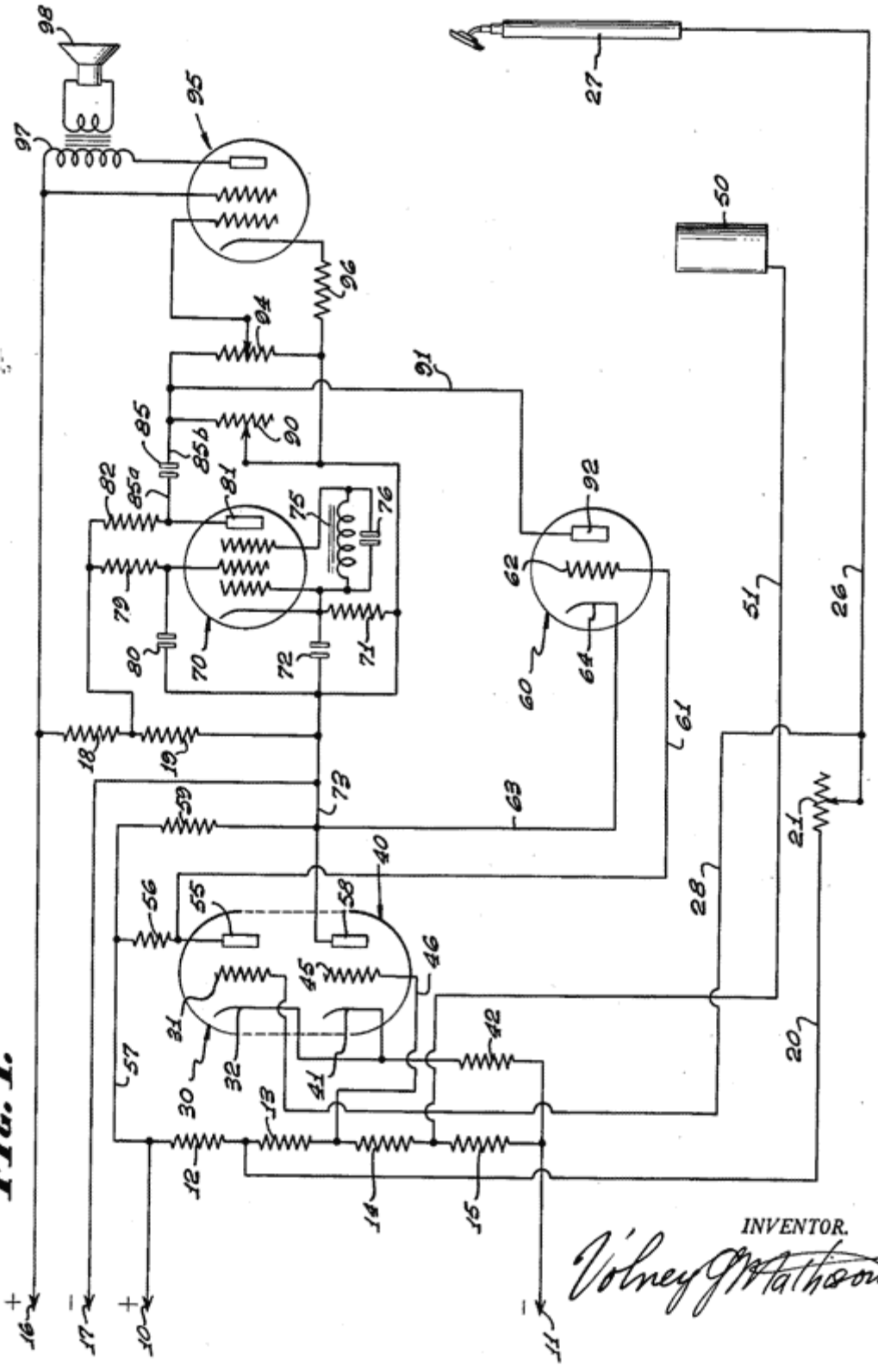

FIG. 1.

INVENTOR.

Volney G. Mathison

ELECTROPSYCHOMETER OR BIOELECTRONIC INSTRUMENT

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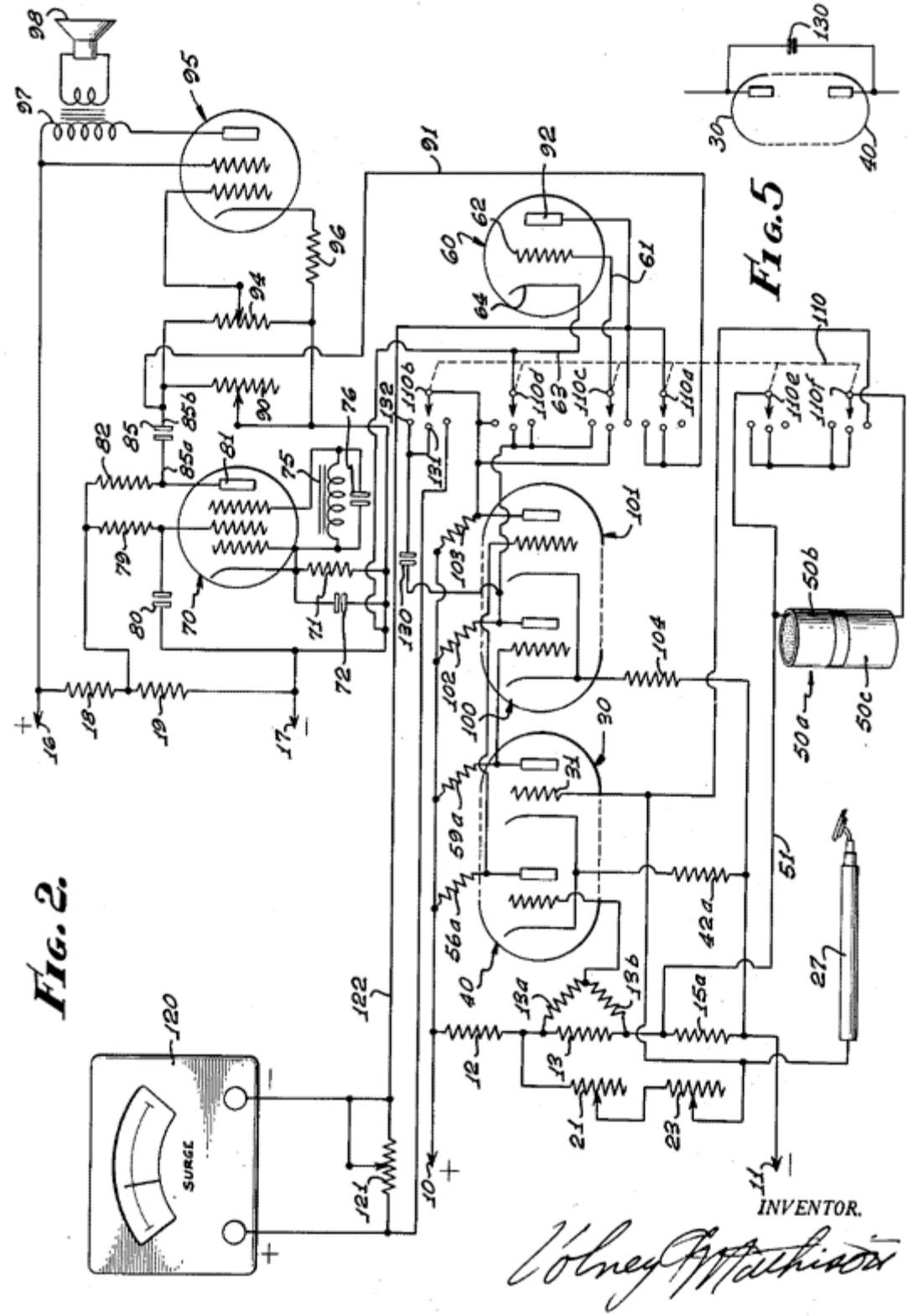

FIG. 2.

FIG. 5

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ELECTROPSYCHOMETER OR BIOELECTRONIC INSTRUMENT

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FIG. 3.

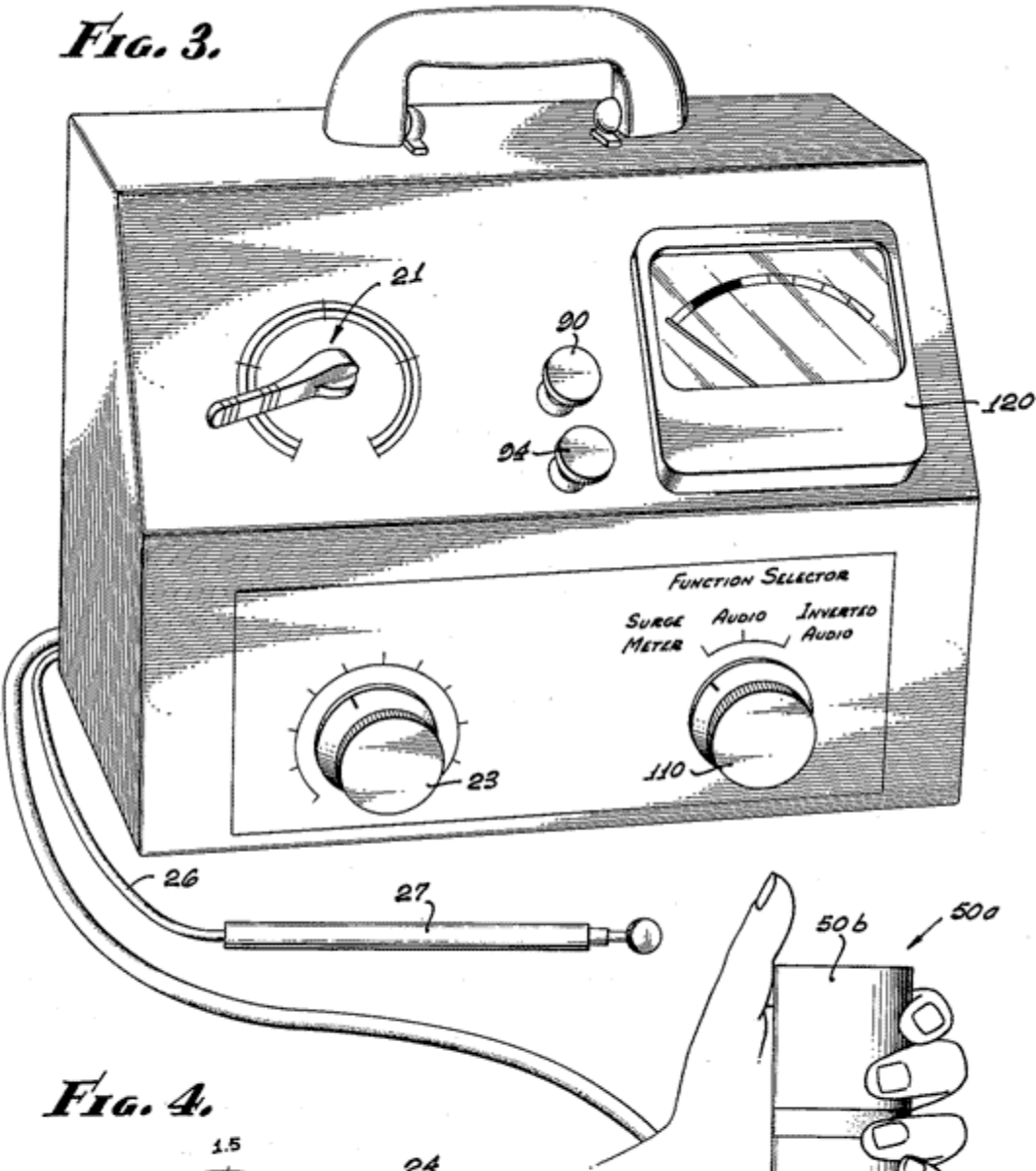
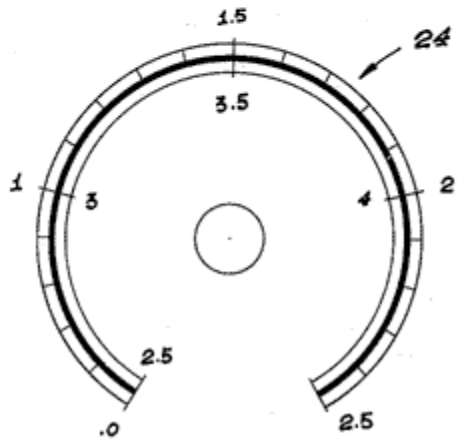


FIG. 4.



INVENTOR.

Volney G. Mathison

United States Patent Office

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2,736,313

ELECTROPSYCHOMETER OR BIOELECTRONIC INSTRUMENT

Volney G. Mathison, Los Angeles, Calif., assignor to Muriel N. Warkentin, Los Angeles, Calif.

Application October 5, 1954, Serial No. 460,384

21 Claims. (Cl. 128—2.1)

The invention disclosed herein is a further modification of my previously disclosed electropsychometer (U. S. Patent No. 2,684,670 and various pending applications).

The present instrument is designed, in the main, for a special application, namely the detection of suboptimum physical conditions in neurospinal areas and in some other areas of the body.

It has been known for many years that if two galvanically differentiated metallic electrodes are applied to the skin of any person, a slight electrical potential will register between the terminals of the said electrodes, and that the value of this potential may increase in a manner more or less related to increasingly suboptimum physical conditions existing below the area of skin surface where the electrodes are being applied. One explanation that has been advanced concerning this phenomenon is that it is caused primarily by bioelectronic potentials that somehow are generated in disturbed neuromuscular structures; that this in turn results in the rapid generation by the affected muscle cells of the fluid known as histamine, which provides paths of low ohmic electrical resistance among the said affected muscle cells or fibres, thereby tending to short-circuit them and discharge the accumulated electrical tensions. It is further presumed that since histamine is a relatively conductive fluid, that it may facilitate the conduction of some portion of the bioelectronic energy in the disturbed areas outward to the nearest skin area. Hence if one of a pair of galvanically differentiated metal plates is slid along the skin surface from normal areas to the vicinity of an area that is affected as described above, an increased electrical potential may be registered between the terminals of the said plates as a result of internal suboptimum conditions.

Several diagnostic instruments have been placed on the market that function on the basis of the above described bioelectronic phenomena. Some of these are insensitive or erratic. Others are of high sensitivity but are expensive because they make use of costly types of highly-damped galvanometers. Some are difficult to use since they are apt to be responsive to variations in the degree of physical pressure with which the contacting electrodes are applied to the skin.

It is also known that if two skin-contacting electrode elements, galvanically differentiated or not, are connected to a sensitive ohmmeter, variations in ohmic resistance may be observed when one or the other electrode is slid about over the surface of the skin, these ohmic variations corresponding substantially to the registrations observed on a galvanometer connected to galvanically differentiated electrodes. However, if the sensitivity of the ohmmeter being used in the experiment is stepped up to a diagnostically useful level, by means, for example, of a direct-current type of vacuum tube amplifier, the action of the indicating needle of the ohmmeter becomes violent and erratic, hence this arrangement has not been much used in actual diagnostic practice.

I have therefore invented the instrument disclosed herein which to a considerable degree overcomes some

of the unsatisfactory operational features of the devices briefly referred to above. My invention comprises, in the main, a novel combination of several previously well known electronic circuits. A part of the input section of the composite circuit of the complete instrument is substantially that disclosed in one of my own previously claimed electropsychometers (U. S. Patent No. 2,684,670), but instead of being used to energize the movement of an electromagnetic indicating meter, the electropsychometric circuit is employed in a special manner to key or trigger a conventional transitron type of audio-frequency oscillator, which in turn drives a simple power-tube amplifier and an associated audio-frequency signalling device, such as a loudspeaker or the like. Hence differential registrations are effected by means of audio-frequency signals rather than by the action of a meter needle, thereby eliminating the costly type of galvanometer sometimes used in instruments of this kind, as has been previously mentioned. The invention, in its complete form, as reduced to practice, is sensitive and precise in its mode of functioning, and the registrations obtained with it are to a practical degree independent of the amount of physical pressure that may be applied to either of the skin-contacting electrodes used with the instrument.

In the accompanying drawings, Fig. 1 is a diagram of the generic circuit of the invention, and includes a view of two skin-contacting electrode elements that may be used with the instrument.

Fig. 2 is a diagram, by way of example, of the complete instrument, as reduced to practice. This diagram discloses an additional stage of vacuum tube amplification. It also discloses an optional switching system whereby the output of the vacuum tube amplifier circuits of the instrument may be transferred to the terminals of an electromagnetic type of indicating meter, and whereby my previously claimed dual-concentric type of hand-held skin-contacting electrode may also be utilized in combination with the other elements of the invention. Hence the circuit shown in Fig. 2 provides for a plurality of functions, including the registration of sub-optimum physical areas by an audio-frequency signal and the registration of electropsychophysical conditions through the detection of combined neuromuscular and galvanic skin reaction responses as indicated on an electromagnetic type of meter, as I have previously claimed.

Fig. 3 is a view of the complete instrument, as reduced to practice. Fig. 4 discloses a modification of my previously claimed electropsychometric tone scale, as I have adapted it for use with the surge-meter circuit of the present instrument. Fig. 5 relates to a minor modification of the circuit shown in Fig. 2.

Referring to the drawings, the numerals **10, 11,** denote the positive and negative terminals of a source of direct current, which may be provided by any conventional type of vacuum tube plate power supply, such as a small transformer, rectifier tube, and filter circuit, or which may be provided by a dry battery. **12, 13, 14, 15** denote four series-connected resistances, forming a voltage-dividing network between the power supply terminals **10, 11.** The numerals **16** and **17** denote the positive and negative terminals of a second vacuum tube plate power supply source, which may or may not be electrically independent of that connected between terminals **10** and **11,** but which, in either case is hereinafter referred to as the second plate power supply source.

Resistances **18, 19** form a second voltage-divider network connected between the terminals **16, 17** of the second plate power supply source. One end of a conductor, **20,** is connected between resistances **12, 13,** and its other end is connected to one terminal of a variable resistance **21.** The other terminal of resistance **21** is connected by a conductor **26** to the terminal of a search-probe type of

skin-contacting electrode element 27. Electrode 27 is also connected by a conductor 28 to the grid element 31 of a vacuum tube 30. The cathode element 32 of vacuum tube 30 is connected to the cathode element 41 of a second vacuum tube 40, and to one terminal of a resistance 42. The other terminal of resistance 42 is connected to the negative terminal 11 of the first plate power supply source. The grid element 45 of vacuum tube 40 is connected by a conductor 46 to a point on the first voltage-dividing network between resistances 13 and 14. A second skin-contacting electrode element 50 is connected by a conductor 51 to a point between resistances 14 and 15 on the said first voltage-dividing network.

The elements and conductors thus far described comprise means for establishing an electrical potential between skin-contacting electrodes 27 and 50, and for relating the value of ohmic resistance existing between the said electrodes to the value of biasing potential appearing at the grid terminal of vacuum tube 30. Also, indirectly through the functioning of resistance 42, these elements and conductors further provide a means for establishing a correlated biasing potential on the grid terminal of vacuum tube 40.

The plate element 55 of vacuum tube 30 is connected to one terminal of a resistance 56. Plate element 58 of vacuum tube 40 is connected to one terminal of another resistance 59. The other terminals of resistances 56 and 59 are connected in common by conductor 57 to the positive terminal 10 of the first plate power supply.

The plate element of vacuum tube 30 is also connected by a conductor 61 to the grid element 62 of a third vacuum tube 60. The plate element of vacuum tube 40 is connected by a conductor 63 to the cathode element 64 of vacuum tube 60.

A fourth vacuum tube 70 is connected as a conventional transitron type of audio-frequency oscillator, the control grid and cathode elements of the said tube 70 being connected together. The said cathode and control grid elements of vacuum tube 70 are connected in common to one terminal of a resistance 71, and may also be connected to one terminal of a condenser 72. The other terminals of the resistance 71 and condenser 72 are connected to a conductor 73 which constitutes a common grounding conductor in the audio-frequency sections of the instrument, the said conductor 73 being connected to the negative terminal 17 of the previously mentioned second plate power supply source. An inductance 75 and a capacitor 76 are connected in parallel between the common control grid and cathode terminals of vacuum tube 70 and the terminal of the suppressor grid 77. The terminal of the screen grid 78 is connected to one terminal of a resistance 79, and to one terminal of a condenser 80. The other terminal of condenser 80 is connected to the common grounding conductor 73. The plate element 81 is connected to one terminal of a resistance 82. The other terminals of resistances 79 and 82 are connected by a conductor 83 to a point between the voltage dividing resistors 18, 19. The terminal of the plate element 81 is also connected to terminal 85*a* of a condenser 85. The other terminal 85*b* of condenser 85 is connected to one terminal of a variable resistance 90. The second terminal of resistance 90 is connected to the common grounding conductor 73. Terminal 85*b* of conductor 85 is also connected by a conductor 91 to the plate element 92 of vacuum tube 60. Terminal 85*b* is also connected to one end terminal of a potentiometer 94. The other end terminal of potentiometer 94 is connected to the common grounding conductor 73. The movable contacting terminal of potentiometer 94 is connected to the terminal of the control grid of a fifth vacuum tube 95. The cathode terminal of vacuum tube 95 is connected through a resistance 96 to grounding conductor 73. The plate terminal of vacuum tube 95 is connected through the primary winding of an output transformer 97 to the positive terminal 16 of the second source of plate power supply. The screen grid terminal of the tube 95 is also connected to positive power supply terminal 16. The secondary winding of the output transformer 97 is connected to the terminals of a small cone-type speaker 98.

The mode of functioning of the instrument, with reference to the generic circuit thus far described is as follows: Variations in ohmic resistance occurring between skin-contacting electrode elements 27 and 50 cause related variations in biasing potential at the grid terminal of vacuum tube 30, and, in a secondary manner, at the grid terminal of vacuum tube 40. Such variations of grid biasing potentials are reflected at the plate terminals of tubes 30 and 40, and also, through conductors 61 and 63, at the grid and cathode terminals of vacuum tube 60. Variations of potential between the grid and cathode terminals of tube 60 cause the occurrence of a variation of ohmic resistance between terminal 85*b* of condenser 85 and the grounding conductor 73. Vacuum tube 70 oscillates at an audio frequency which is determined by the values of inductance 75 and capacitor 76. The type of tube employed at 70 and the potentials applied to it are such that this oscillator has a critical starting and stopping characteristic with relation to the value of ohmic resistance existing between terminal 85*b* of condenser 85 and ground conductor 73. When the resistance between terminal 85*b* and ground conductor 73 is reduced to a certain value, the oscillator fully operates. When the resistance is increased slightly above this critical value, the oscillator completely stops functioning. The critical point of oscillation versus non-oscillation, which I have designated as the oscillator cut-off point, is determined by a manual adjustment of the variable resistance 90, which I have designated as the oscillator cut-off control.

Since the plate and cathode terminals of vacuum tube 60 are also connected between terminal 85*b* of condenser 85 and the grounding conductor 73, variations in ohmic resistance between the plate and cathode terminals of the said tube 60, as triggered by variations in potential appearing between the grid and cathode elements of tube 60, cause a sharp starting and stopping response of the transitron oscillator tube 70.

The potentiometer 94, which is also connected between terminal 85*b* and ground conductor 73, is of much higher ohmic resistance than that of the variable resistance 90, and it provides a means for transferring the audio-frequency signals generated by the transitron oscillator to the grid terminal of an audio frequency output power tube 95. Potentiometer 94 also affords a means for varying the volume of the audio frequency signal at the cone-speaker element 98, but owing to its relatively high resistance has slight effect on the action of the transitron oscillator.

The over-all mode of functioning of the generic circuit of the invention may therefore be summarized by stating that variations in the value of ohmic resistance existing between the skin-contacting electrode elements 27 and 50 are reflected in amplified variations of ohmic resistance between the plate and cathode elements of vacuum tube 60, which functions as a trigger tube for starting and stopping the transitron oscillator tube 70, the output of the said transitron oscillator tube being used to drive the grid of a small output power type of vacuum tube which in turn operates an audio-frequency signalling device.

Although the instrument will function to a usable degree if it comprises only the generic elements disclosed in Fig. 1, I prefer in an actual reduction to practice to use the additional elements shown in Fig. 2.

The first group of additional elements which I shall describe comprise an added stage of amplification. This is provided by the vacuum tubes 100, 101 (Fig. 2) the plate terminals of which are connected through the resistances 102 and 103 to the positive plate supply source terminal 10. The grid terminals of tubes 100 and 101 are connected to the plate terminals of the previously

described tubes 30 and 40. The cathode terminals of tubes 100, 101 are connected through a common resistance 104 to negative power supply terminal 11. Vacuum tubes 100, 101 and the resistances associated directly with them provide a second stage of amplification between the skin-contacting electrode elements 27 and 50*a*, and the trigger tube 60.

In Fig. 2 I also disclose the addition of a manually operated switching system comprising a six-pole three-position rotary switch 110, (Fig. 3) which is designated as a function selector. The three available positions of the switch 110 are designated herein as the central position, the upper position, and the lower position, with reference to Fig. 2. The central position is designated as the position for audio registration; the upper position as the position for inverted audio registration, and the lower position as the position for surge-meter registration. The right-hand position of the function selector control 110 as shown in Fig. 3 corresponds to the upper position of the switching system as shown in Fig. 2. The central position of this control shown in Fig. 3 corresponds to the central position of the switching system of Fig. 2. The left-hand position designated as the position for surge-meter registration in Fig. 3 corresponds to the lower position of the switching system of Fig. 2. When the function selector control switch is set at the central position, as shown in Fig. 2, the plate terminals of vacuum tubes 100, 101 are connected to the grid and cathode terminals of the trigger tube 60 through the conductors 61 and 63, so that the instrument functions in the manner previously described with reference to Fig. 1; that is, a drop in ohmic resistance occurring between the terminals of the skin-contacting electrodes 27 and 50*a* causes the registration of an audio signal on the cone speaker 98.

When the function selector switch 110 is moved to the upper position, as indicated by dotted lines in Fig. 2, the amplified variations of ohmic resistance appearing between the plate and cathode elements of the trigger tube 60 are inverted; that is, a drop in ohmic resistance between the terminals of the skin-contacting electrodes 27 and 50*a* causes an increase in resistance between the plate and cathode elements of tube 60. When the function selector is in this position the instrument is so adjusted as to generate a continuous audio frequency signal until a drop of resistance occurs between the skin-contacting electrodes, which causes an increase in resistance through the trigger tube 60 and a consequent cessation of oscillation of the transitron tube 70, so that the instrument becomes silent.

When the function selector switch 110 is moved to the lower position, (Fig. 2) conductor 91 is disconnected from the plate terminal of vacuum tube 100, as is apparent by noting the lower position of switch pole 110*a*. Simultaneously, the plate terminal of tube 101 is connected through switch pole 110*b* to the positive terminal of an electromagnetic type of indicating meter 120. The negative terminal of meter 120 is connected by conductor 122 to the plate terminal of vacuum tube 60. The plate terminal of vacuum tube 60 is also now connected through switch pole 110*c* to the grid terminal of the said tube 60, so that this tube may now function as a diode rectifier. The cathode terminal of tube 60 remains connected to the plate terminal of tube 100 through the switch pole 110*d*. Thus, when the function selector switch is moved into this lower position, the winding of the indicating meter 120 is connected in series with the elements of vacuum tube 60 which now operates as a diode rectifier, and these two series-connected elements, meter 120 and tube 60 are connected across the plate terminals of vacuum tubes 100 and 101.

In the case of the circuit disclosed in Fig. 2, the plain cylindrical electrode designated by the numeral 50 (Fig. 1) is replaced by my previously claimed dual-concentric type of electrode 50*a*, consisting of two cylindrical skin-contacting elements mounted on a common insulating member. When the function selector switch 110 is in either the central or upper position, the two conductive elements of electrode 50*a* are electrically connected together through switch poles 110*e* and 110*f*, and act as a single skin-contacting electrode, substantially equivalent to electrode 50 (Fig. 1). When the function selector switch 110 is moved to the lower position, the conductive elements of electrode 50*a* are disconnected from each other. One conductive element, 50*b*, remains connected by conductor 51 to a point on the voltage divider system between resistances 13 and 15. The other conductive element, 50*c*, is connected through the switch pole 110*f* to the grid terminal 31 of vacuum tube 30. When the function selector switch 110 is in this lower position, the instrument functions in a manner substantially similar to that of my originally claimed electropsychometer. (U. S. Patent 2,684,670.) Fluctuations in ohmic resistance occurring between the two skin-contacting elements of electrode 50*a* cause a variation of potential at the terminals of the electromagnetic indicating meter 120, and a unidirectional flow of current through the winding of meter 120 is obtained as a consequence of the rectifying action of vacuum tube 60 which is switched into a series connection with the said meter. The numeral 121 denotes a potentiometer which is shunted across the terminals of meter 120, thereby affording a means for varying the sensitivity of response of the instrument when meter 120 is in use.

With further reference to Fig. 2, an additional adjuvant element is a condenser 130, one terminal of which is connected to the plate terminal of vacuum tube 100. The other terminal of condenser 130 is connected to two adjacent switch contacts, 131 and 132, which are contacted by switch pole 110*b*. Switch pole 110*b* is connected, as previously described, to the plate terminal of vacuum tube 101. When the function selector switch 110 is moved into either the central or upper position, condenser 130 is connected across the plate terminals of tubes 100 and 101, and, consequently, it is also connected across the grid and cathode terminals of vacuum tube 60. Condenser 130, when connected into the circuit in the manner disclosed, markedly sharpens the starting and stopping characteristic of the transitron oscillator tube 70, and causes the search-probe registration of the instrument to be much more discriminative and precise than can otherwise be obtained. A substantially similar effect can be had by connecting condenser 130 across the plate terminals of tubes 30 and 40, this alternative connection being shown in Fig. 5.

When the function selector switch is moved into the lower position for surge-meter operation, one terminal of condenser 130 is disconnected from the plate terminal of vacuum tube 101 through the movement of switch pole 110*b*.

I do not wish the invention limited to include any of the added elements disclosed in Fig. 2. Any or all of these elements may be added to those elements disclosed in Fig. 1, in several possible combinations. For example, only the second stage amplifier comprised by tubes 100, 101 and associated resistances may be added to the circuit of Fig. 1. The condenser 130 may be connected permanently across the cathode and grid terminals of the trigger tube 60, the function selector switch 110 being omitted. The dual-concentric skin-contacting electrode structure 50*a* may be replaced by some other systemic arrangement of skin-contacting electrodes. The surge meter 120 may be omitted, the instrument in that case being designed to operate only as an audio-registration type of device. The inverting circuit arrangement which is brought into use when the function selector switch is moved into the upper position may be omitted.

In the foregoing specification, and in all of the claims appended hereto, the several vacuum tubes that are included in the circuits of the invention are designated and described as being separate tubes. Some or all of the

said tubes may in practice be the sections of twin-type tubes. In my own reduction to practice of the invention, vacuum tubes **30** and **40** (Fig. 1) are the two sections of a twin type 6SN7 tube. In the case of the circuit of the complete instrument, as shown in Fig. 2, tubes **30** and **40** are the two sections of a type 6SC7 or 6SL7 tube. Vacuum tubes **100**, **101** are the two sections of a type 6SN7 tube. Trigger tube **60** may be a 6SF5. Transitron oscillator tube **70** may be a 6SK7. Output tube **95** may be a 6V6 or the like.

Another useful element that may be added to the invention is a calibrated scale **24** (Fig. 4) which may be placed under an indicating lever attached to the variable resistance **21** (Figs. 1, 2, 3). Scale **21** may register the ohmic value of resistance existing between the terminals of the system of skin-contacting electrode elements. I prefer, however, that it register in the values of my previously claimed electropsychometric tone scale, wherein the numeral .5 denotes a resistance of about 500 ohms or more, the numeral 1.0 denotes a resistance of 2000 ohms or more, the numeral 1.5 a resistance of 5,000 ohms or more, the numeral 2.0 a resistance of 22,000 ohms or more, 2.5 a resistance of 50,000 ohms or more, 3.0 a resistance of 100,000 ohms or more, 4.0 a resistance of 300,000 ohms or more, the said numeration being with reference to the values of ohmic resistance existing between the terminals of my previously claimed dual-concentric type of hand-held skin-contacting electrode.

Variable resistance **21** may be connected in series with a second variable resistance **23** (Figs. 2 and 3) which may act as an expander or multiplier, so that the adjustment of the tone-scale indicating resistance **21** is broadened and less critical. The addition of the second variable resistance **23** in series with resistance **21** also facilitates search-probe registrations in cases of very high skin resistances. In my own reduction to practice of the invention, I employ a dual type of resistance-indicating scale **24** (Fig. 4) the said scale being mounted in a registrative relationship to variable resistance **21**, (Fig. 3) the outer calibration of scale **24** being with reference to an adjustment of variable resistance **23** whereby the ohmic resistance of **23** is of a rather low value, and the inner calibration of scale **24** is with reference to an altered adjustment of resistance **23**, whereby the ohmic resistance of **23** is considerably increased. The characters placed on scale **24** are with reference to my previously described electropsychometric system of calibration, wherein the numerals 1.5 and other numerals of lesser value are presumed to relate to an acutely disturbed condition, numerals between 2.0 and 2.5 are presumed to relate to average normal conditions, and the numeral 2.5 and or other numerals of higher values being presumed to relate to more or less optimum conditions, the said system of numeration being with reference to the presumed psychophysical condition of a person to whom the skin-contacting electrode elements of the invention are applied.

In the first ten claims appended hereto, vacuum tube **30** (Fig. 1) is designated as the first vacuum tube, tube **40** as the second tube, tube **60** as the third tube, tube **70** as the fourth tube, tube **95** as the fifth tube.

In claims numbered from eleven to twenty one, inclusive, vacuum tube **30** is designated as the first tube, tube **40** as the second tube, tube **100** as the third tube, tube **101** as the fourth tube, tube **60** as the fifth tube, tube **70** as the sixth tube, tube **95** as the seventh tube.

The types of tubes used may be as previously described above. The values of the other elements of the invention, as disclosed in Fig. 1, may be as follows: **12**, 56K; **13**, 2700 ohms; **14**, 2700 ohms, **15**, 27K; **18**, 56; **19**, 56K; **21**, 150K; **42**, 27K; **56**, 27K; **59**, 27; **71**, 2700 ohms; **72**, 1 mfd.; **75**, 2 henries or less; **76**, .01 mfd. or less; **80**, .25 mfd.; **85**, .05 mfd.; **90**, 150K; **94**, .5 meg. or more, **96**, 600 ohms. The potential between power supply terminals **10** and **11** may be 250 volts; between terminals **16** and **17** of the second power supply source, 250 volts.

With reference exclusively to Fig. 2, the values of the elements shown may be as follows: **12**, 56K; **13**, 2700 ohms; **13***a*, 250K, **13***b*, 330K; **15***a*, 2700 ohms; **21**, 150K; **23**, 250K; **42***a*, 22K; **56***a*, 220K; **59***a*, 220K; **102**, 27K; **103**, 27K; **121**, 10K; **130**, 8 mfd. Function selector switch **110** (Fig. 3) may be a Centralab #1417. Meter **120** may have a range of from 0–50 microamperes, direct current. Values of remaining elements shown in Fig. 2. may be ascertained by referring to values suggested in the preceding paragraph with reference to Fig. 1.

In claims numbered from eleven to twenty-one, inclusive, vacuum tube **30** is designated as the first tube, tube **40** as the second tube, tube **100** as the third tube, tube **101** as the fourth tube, tube **60** as the fifth tube, tube **70** as the sixth tube, tube **95** as the seventh tube.

The types of tubes used may be as described in a preceding paragraph. The values of the other elements of the invention may be as follows: **12**, 56K; **13**, 2700 ohms; **14**, 2700 ohms; **15**, 27K; **18**, 56K; **19**, 56K; **21**, 150K; **42**, 27K; **56**, 27K; **59**, 27K; **71**, 2700 ohms; **72**, 1 mfd.; **75**, 2 henries or less; **76**, .01 mfd. or less; **79**, 100K, **80**, .25 mfd., **82**, 56K; **85**, .05 mfd.; **90**, 150K, **94**, .5 meg. or more, **96**, 600 ohms. The potential between power supply terminals **10** and **11** may be 250 volts; between terminals **16** and **17** of the second power supply source, 250 volts.

With reference to Fig. 2, the values of added, or altered elements may be as follows: **13***a*, 250K; **13***b*, 330K; **15***a*, 2700 ohms; **23**, 250K; **42***a*, 22K; **56***a*, 220K; **59***a*, 220K; **102**, 27K; **103**, 27K; **104**, 27K; **121**, 10K; **130**, 8 mfd. Function selector switch **110** (Fig. 3) may be a six-pole three-position Centralab #1417, or the like. Meter **120** may have a range of from 0–50 microamperes, direct current. The values of elements of Fig. 2 not given in this paragraph may be ascertained by referring to the values suggested in the preceding paragraph with reference to Fig. 1.

I claim:

1. An audio-registration type of electropsychometer or bioelectronic instrument comprising five vacuum tubes, or a lesser number of twin type tubes functioning as five separate tubes and hereinafter designated as the first, second, third, fourth and fifth vacuum tubes, a transitron oscillator, an audio-frequency amplifier and audio signalling device, and a system of skin-contacting electrode elements, means for establishing an electrical potential between the terminals of the said system of skin-contacting electrode elements, means for relating the ohmic resistance existing between the terminals of the said system of skin contacting electrodes to the values of biasing voltages appearing at the grid terminals of the above-mentioned first and second vacuum tubes, means for establishing an electrical potential between the plate and cathode elements of the said first and second vacuum tubes, two conductors, one from each plate terminal of the aforesaid first and second vacuum tubes, to the grid and cathode elements of a previously mentioned third vacuum tube, a transitron type of audio-frequency oscillator, the said oscillator consisting of a previously mentioned fourth vacuum tube and the associated resistances and capacitors required to constitute the said transitron oscillator, and including a capacitor, the said capacitor being designated as a transitron plate circuit capacitor, one terminal of the said capacitor being connected to the plate terminal of the aforesaid fourth vacuum tube, the other terminal of the said capacitor being connected to the plate terminal of the previously mentioned third vacuum tube, means for connecting the cathode and control-grid terminals of the aforesaid fourth vacuum tube in common to the cathode terminal of the aforesaid third vacuum tube, means for applying the audio-frequency signalling potential generated by the aforesaid transitron oscillator to the grid terminal of a previously mentioned

fifth vacuum tube, the said fifth vacuum tube functioning as an audio-frequency amplifier and operating an audio-frequency signalling device, means for adjusting the operating characteristics of the instrument, whereby the registration or non-registration of a signal by the above-mentioned audio-frequency signalling device is governed by the value of ohmic resistance existing between the terminals of the afore mentioned skin-contacting electrode elements.

2. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in the preceding claim, designated as claim No. 1, and with the addition of a capacitor, means for connecting one terminal of the said capacitor to the grid terminal of the previously mentioned third vacuum tube, means for connecting the other terminal of the said capacitor to the cathode terminal of the said third vacuum tube.

3. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 1, and with the addition of a switching system which provides a means whereby the two previously mentioned conductors attached to the plate terminals of the previously mentioned first and second vacuum tubes are reversible with reference to their mode of connections to the grid and cathode terminals of the previously mentioned third vacuum tube.

4. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connection thereof set forth in a preceding claim, designated as claim No. 1, and with the addition of an electromagnetic type of indicating meter, means for substantially disconnecting the plate terminals of the previously mentioned first and second vacuum tubes from the previously mentioned transitron oscillator and for connecting the said plate terminals to the terminals of the aforesaid electromagnetic type of indicating meter.

5. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 1, and with the addition of an electromagnetic type of indicating meter, means for substantially disconnecting the plate terminals of the previously mentioned first and second vacuum tubes from the previously mentioned transitron oscillator and for connecting the said plate terminals to the terminals of the aforesaid electromagnetic type of indicating meter, means for reconnecting the grid and plate elements of the previously mentioned third vacuum tube, whereby the said third vacuum tube functions as a diode rectifier, means for connecting the said vacuum tube in series with the winding of the above-mentioned indicating meter.

6. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 1, and with the addition of a switching system to provide a means whereby one or more of a plurality of skin-contacting electrode elements may be selectively connected to or disconnected from the other elements of the invention.

7. An audio-registration type of electropsychometer, or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 1, but with the modification that the system of skin-contacting electrodes mentioned in claim No. 1 comprises two electrically conductive skin-contacting elements mounted on a common insulating member.

8. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 1, and with the addition of a plurality of systems of skin-contacting electrode elements, one of the said systems of electrodes consisting of two or more electrically conductive elements mounted on a common insulating member, means whereby one or more of the said skin contacting elements may be selectively connected to or disconnected from the other elements comprising the invention.

9. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 1, and with the addition of an indicating scale or system of scales, the said scale or system of scales being mounted in a registrative relationship to an adjustable control or controls, whereby the registrations appearing on the said scale or system of scales are related to the values of ohmic resistance existing between the terminals of the previously mentioned system or systems of skin-contacting electrode elements.

10. An audio-registration type of electropsychometer or bioelectronic instrument comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 1, and with the addition of a system of indicating scales, the said system of indicating scales being mounted in a registrative relationship to an adjustable control or system of controls whereby registrations appearing on the said system of indicating scales are related to the values of ohmic resistance existing between the terminals of the previously mentioned system or systems of skin-contacting electrode elements, the aforesaid system of indicating scales being calibrated in the numerals of the electropsychometric tone scale, the said electropsychometric tone scale having a system of numeration from 1.0 or less to 4.0 or more, the numerals below 1.5 being presumed to relate to acutely disturbed psychophysical conditions, the numerals from 2.0 to 2.5 being presumed to relate to average normal psychophysical conditions, and numerals above 2.75 being presumed to relate to more or less optimum psychophysical conditions, the said system of electropsychometric numeration being with reference to the case of a person to whom the previously mentioned system or systems of skin-contacting electrodes are applied.

11. An audio-registration type of electropsychometer or bioelectronic instrument, comprising seven vacuum tubes or a lesser number of twin type tubes functioning as seven separate tubes and hereinafter designated as the first, second, third, fourth, fifth, sixth, and seventh vacuum tube, a transitron type of audio-frequency oscillator, an audio-frequency amplifier and signalling device, and a system of skin-contacting electrode elements, means for establishing an electrical potential between the terminals of the said system of skin-contacting electrode elements, means for relating the ohmic resistance existing between the terminals of the said system of skin-contacting electrode elements to the biasing voltages appearing at the grid terminals of the above-mentioned first and second vacuum tubes, means for connecting the plate terminals of the said first and second vacuum tubes to the grid terminals of the previously mentioned third and fourth vacuum tubes, means for establishing an electrical potential between the plate and cathode elements of the said first, second, third, and fourth vacuum tubes, two conductors, one from each plate terminal of the aforesaid third and fourth vacuum tubes, to the grid and cathode elements of a previously-mentioned fifth vacuum tube, a transitron type of audio-frequency oscillator consisting of a previously mentioned sixth vacuum tube and the associated resistances and capacitors required to constitute the said transitron oscillator,

and including a capacitor, the said capacitor being designated as the transitron plate circuit capacitor, one terminal of the said capacitor being connected to the plate terminal of the previously mentioned fifth vacuum tube, means for connecting the cathode and control-grid terminals of the aforesaid sixth vacuum tube in common to the cathode terminal of the aforesaid fifth vacuum tube, means for applying the audio-frequency signalling potential generated by the aforesaid transitron oscillator to the grid terminal of a previously mentioned seventh vacuum tube, the said seventh vacuum tube functioning as an audio-frequency amplifier and operating an audio-frequency signalling device, means for adjusting the operating characteristics of the instrument whereby the registration or non-registration of signals by the above-mentioned audio-frequency signalling device is governed by the value of ohmic resistance existing between the terminals of the afore-mentioned system of skin-contacting electrode elements.

12. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in the preceding claim, designated as claim No. 11; and with the addition of a capacitor, means for connecting one terminal of the said capacitor to the grid terminal of the previously mentioned fifth vacuum tube, means for connecting the other terminal of the said capacitor to the cathode terminal of the said fifth vacuum tube.

13. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11; and with the addition of a capacitor, means for connecting one terminal of the said capacitor to the plate terminal of the previously mentioned first vacuum tube, means for connecting the other terminal of the said capacitor to the plate terminal of the previously mentioned second vacuum tube.

14. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11; and with the addition of a switching system which provides a means whereby the two previously mentioned conductors attached to the plate terminals of the previously mentioned third and fourth vacuum tubes are reversible with reference to their mode of connections to the grid and cathode terminals of the previously mentioned fifth vacuum tube.

15. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11; and with the addition of an electromagnetic type of indicating meter, means for substantially disconnecting the plate terminals of the previously mentioned third and fourth vacuum tubes from the previously mentioned transitron oscillator and for connecting the said plate terminals to the terminals of the aforesaid electromagnetic type of indicating meter.

16. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11, and with the addition of an electromagnetic type of indicating meter, means for substantially disconnecting the plate terminals of the previously mentioned third and fourth vacuum tubes from the previously mentioned transitron oscillator and for connecting the said plate terminals to the terminals of the aforesaid electromagnetic type of indicating meter, means for reconnecting the grid and plate elements of the previously mentioned fifth vacuum tube, whereby the said fifth vacuum tube functions substantially as a diode rectifier, means for connecting the said vacuum tube in series with the winding of the above-mentioned indicating meter.

17. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11; and with the addition of a switching system which provides a means whereby one or more of a plurality of skin-contacting electrode elements may be selectively connected to or disconnected from the other elements of the invention.

18. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11; but with the modification that the system of skin-contacting electrodes mentioned in claim No. 11 comprises two electrically conductive skin-contacting elements mounted on a common insulating member.

19. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the element, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11; and with the addition of a plurality of systems of skin-contacting electrode elements, one of the said system of electrodes consisting of two or more electrically conductive elements mounted on a common insulating member, means whereby one or more of the said skin-contacting electrode elements may be selectively connected to or disconnected from the other elements comprising the invention.

20. An audio-registration type of electropsychometer or bioelectronic instrument, comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11, and with the addition of an indicating scale or system of scales, the said scale or system of scales being mounted in a registrative relationship to an adjustable control or controls, whereby the registrations appearing on the said indicating scale or system of indicating scales are related to the values of ohmic resistance existing between the terminals of the previously mentioned system or systems of skin-contacting electrode elements.

21. An audio-registration type of electropsychometer or bioelectronic instrument comprising the elements, members, and conductors, and having the relationships and connections thereof set forth in a preceding claim, designated as claim No. 11, and with the addition of a system of indicating scales, the said system of indicating scales being mounted in a registrative relationship to an adjustable control or system of controls whereby registrations appearing on the said system of indicating scales are related to the values of ohmic resistance existing between the terminals of the previously mentioned system or systems of skin-contacting electrode elements, the aforesaid system of indicating scales being calibrated in the numerals of the electropsychometric tone scale, the said electropsychometric tone scale having a system of numeration from 1.0 or less to 4.0 or more, the numerals below 1.5 being presumed to relate to acutely disturbed psychophysical conditions, the numerals from 2.0 to 2.5 being presumed to relate to average normal psychophysical conditions, and numerals above 2.75 being presumed to relate to more or less optimum psychophysical conditions, the said system of electropsychometric numeration being with reference to the case of a person to whom the previously mentioned system or systems of skin-contacting electrode elements are applied.

No references cited.